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TRANSIT TEMPERATURES

of

CUT FLOWERS SHIPPED

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Agricultural Marketing Service
Market Quality Research Division

ACKNOWLEDGMENTS

The cooperation and assistance of the following organizations and firms are gratefully acknowledged:

The California Floral Traffic Conference, San Francisco, Calif. for providing financial assistance and helping arrange shipping tests.

The Southern California Floral Association, Los Angeles, Calif., for assistance in arranging shipping tests.

The following shippers for providing test packages:

Greenleaf Wholesale Florists, Union City, Calif.
Lee Brothers Wholesale Florists, San Mateo, Calif.
Mt. Eden Mums, Mountain View, Calif.
Mt. Eden Roses, Mt. Eden, Calif.
San Lorenzo Nursery Company, Los Angeles, Calif.
Santa Barbara Flower Growers, Los Angeles, Calif.
Western Wholesale Florists, San Mateo, Calif.

The following receivers for assistance in wholesale handling:

Allied Cut Flower Co., New York, N. Y.
Hall Wholesale Florists, Orlando, Fla.
McCallum Sauber Co., Washington, D. C.
S. S. Pennock Co., New York, N. Y., Washington, D. C. and Orlando, Fla.
Paul's Wholesale Florists, Washington, D. C.
Pletcher's Florists and Nursery, Harlingen, Tex.
A. Sauter Co., New York, N. Y.
United Cut Flowers, New York, N. Y.

The following suppliers of experimental containers:

American Box Company, Newark, Calif.
Fome-cor Corporation, Springfield, Mass.

The following airlines for assistance in shipping tests:

American Airlines, Delta Air Lines, Eastern Air Lines, National Airlines, The Flying Tiger Line, Inc., Riddle Airlines, Trans World Airlines, and United Air Lines.

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Washington, D. C. January 1962

TRANSIT TEMPERATURES IN CUT FLOWERS SHIPPED FROM CALIFORNIA

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SUMMARY AND CONCLUSIONS

Studies were conducted to determine transit temperatures and shelf life of California-grown flowers shipped by rail, air, or truck to eastern and southern markets.

Transit temperatures of flowers shipped by air in the winter months may range from 50° to 60° F., although they may be lower than this at transfer points and terminal markets. In the summer the range in transit is usually from 65° to 75°, with higher peaks at transfer points or at the destination. Temperatures between 60° and 70° are typical of the spring months, but the range may be higher than this in shipments to the southern states. Time from packing to delivery in Orlando, Fla., ranged from 42 to 48 hours. Delivery in New York, N. Y., or Washington, D. C., took 20 to 28 hours.

Temperatures in summer rail shipments were mostly in the 40° to 50° F. range in the refrigerated express car, but were frequently in the 70° to 80° range at transfer points and when carried in an unrefrigerated baggage car. Time from packing to delivery in Orlando, Fla., was about 5 days in rail express shipments.

Temperatures in summer truck shipments were generally in the 50° to 60° F. range in the refrigerated van, but were also in the 70° to 80° range at transfer points. Time from packing in Los Angeles to delivery in Harlingen, Tex. was about 72 hours.

The problem of poor refrigeration before loading, at transfer points, and at terminal markets, was common to all three modes of transportation. The times spent at excessively high temperatures were frequently from 12 to 24 hours. Although the time in flight has been reduced with jet service and improved schedules to certain markets, the time from packing to delivery has not been reduced proportionately.

The use of package ice helped to maintain low flower temperatures during exposure to high ambient temperature, but the temperatures within a package were far from uniform. Temperature differences between the ends and centers of the packages were sometimes as great as 28° F.

Flowers shipped in the tests have arrived in fairly good condition and have had fairly good shelf life. However, the temperatures observed in transit indicate that the shelf life may have been reduced to one half or less that which the flowers could have

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had, if transported at ideal temperatures. Lower transit temperatures would bring rewards, in both improved quality and shelf life.

BACKGROUND

Time and temperature are the major factors controlling deterioration during the marketing of cut flowers. Shipping flowers by air provides an advantage in time over other modes of transportation, but frequently is accompanied by a disadvantage in respect to temperature. In truck or rail shipments, which have longer times in transit, good refrigeration is essential to the maintenance of flower quality. Most flowers have a low tolerance for adverse temperatures, even for short transit periods.

Temperature has a direct effect on the activity of decay-causing organisms and also on the respiration rates of flowers. The respiration rate is an index of the rate a flower (or other plant material) is using up its stored reserves of sugar or other substrates and, therefore, it is an indication of shelf life. The higher the respiration rate, the shorter the shelf life of a given commodity. In roses, for example, temperature has a profound effect on respiration rates.[2] The respiration rate is over three times as fast at 59° F. as it is at 41° and over six times as fast at 77° as at 41°. Another way of expressing this temperature effect is to say that a 1-day transit period by air at 59° is equivalent to a 3-day transit period by rail or truck at 41°, assuming that these temperatures were maintained and there were no other complicating factors. Unfortunately, temperatures in both air and ground shipments are frequently much higher than either of these examples. Recommended temperatures and storage times for the cut flowers used in the shipping tests are shown in table 1.

TABLE 1.--Recommended temperatures of storage life of cut flowers studied in shipping tests[1]

Flower	Temperature	Storage Life[2]
	°F	Days
Aster (China).....	40	7
Carnation.....	33 (wholesale)	7
	40 (retail)	4
Chrysanthemum.....	35	14
Daisy (English).....	40	3
Rose:		
Tight buds.....	40	4 to 5
Loose buds.....	40	2 to 3
Stock (common).....	40	3

[1] From Wright, R. C., et al. The Commercial Storage of Fruits, Vegetables, and Florists and Nursery Stocks. U. S. Dept. Agr. Handb. 66, 77 pp. 1954.
[2] Flowers held longer than these times at indicated temperatures probably would not have enough display life to satisfy consumers.

[2] Siegelman, H. W. 1952. The respiration of rose and gardenia flowers. Amer. Soc. Hort. Sci. Proc. 59: 496-500.

METHODS

Test packages were prepared in commercial packing plants in the San Francisco Bay area and in the Los Angeles wholesale market. In most tests certain bunches of flowers were labeled to facilitate their recovery for holding tests at terminal markets.

Temperatures were taken from time of packing to delivery by placing recording thermometers in the cartons. Both Friez recorders, which operate for 30 hours, and Ryan recorders, which operate for 15 days, were used. In most of the shipments instruments were placed at one end and at the center of each carton to determine temperature variation within containers.

Flowers were rated for quality on arrival at terminal markets and after holding for simulated storage and marketing periods.

SHIPPING TESTS TO EASTERN MARKETS

Chrysanthemum Shipment to Orlando, Fla.

Temperatures were studied in chrysanthemums shipped in August from Mountain View, Calif., to Orlando, Fla. (fig. 1). The "mums" were packed in the conventional carton, lined with newspaper to help insulate the flowers from outside temperatures. Comparable lots with initial temperatures near 66° F. were shipped by rail express and by air. The temperatures of the express shipment dropped rather rapidly to the 40° to 45° range. The express car was refrigerated to Atlanta, Georgia, but at this point the flowers were transferred to an unrefrigerated baggage car. There was a rapid rise in temperature to about 80°. The total time in transit was about 5 days.

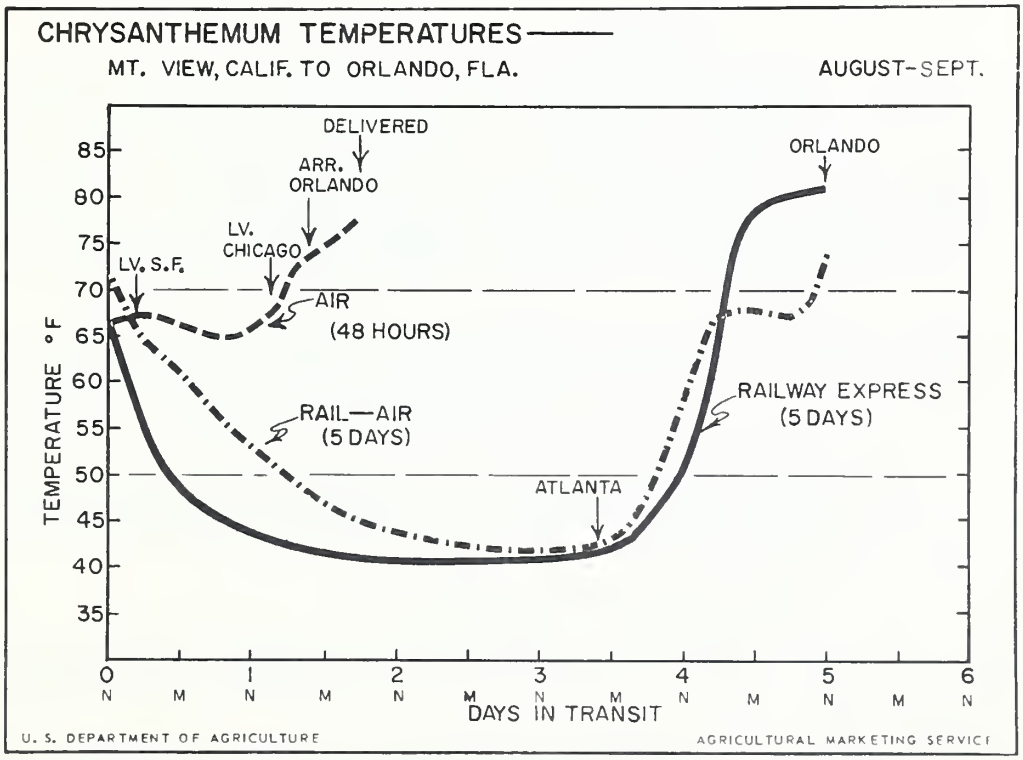

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Figure 1. --Transit times and temperatures of chrysanthemums shipped from Mt. View, Calif., to Orlando, Fla. Air shipment and rail express shipment made on Aug. 5, 1960; combined rail express-air shipment made on Sept. 26, 1960.

The air shipment left at the same time and there was no cooling in transit--the temperatures remained in the 65° to 70° F. range as far as Chicago. At this transfer point there was a rapid rise in temperature to 70° to 75° and on arrival in Orlando the temperature was about 75°. A further rise to almost 80° occurred before the flowers were delivered. Forty-eight hours had elapsed between the time of packing and delivery at the florists in Orlando.

How did the quality of the flowers compare in these two shipments? The flowers shipped by rail were slightly wilted on arrival, but recovered when placed in water. They remained salable for 2 days at 70° F. after holding for 4 days at 45°.

The flowers in the air shipment had good appearance on arrival and remained salable for 4 days at 70° F. after holding 4 days at 45° F. The flowers in the air shipment, therefore, had about 2 days more display life than those in the rail shipment.

The obvious problem in shipping flowers by rail was the high temperature between Atlanta and Orlando. A second test, therefore, was made in which the flowers were shipped by rail to Atlanta and by air from Atlanta to Orlando. In this particular shipment (fig. 1) the flowers were somewhat warmer initially than in the earlier test, and they cooled quite slowly during the rail portion of the transit period. There was, again, a rapid rise in temperature at the Atlanta transfer point, but not quite so high as in the previous tests. The flowers apparently were held almost 18 hours before making the air connection. The actual time from packing to delivery was about the same in the combined rail-air shipment as it was in the all-rail test.

On arrival the flowers were again slightly wilted, but they recovered when placed in water and remained salable for 3 days at 70° after holding for 4 days at 40°.

Rose Shipment to Orlando, Fla.

Roses are usually shipped with package ice in an attempt to improve transit temperatures and provide protection at transfer points. In a test shipment of roses from San Francisco to Orlando made in September 1960 (fig. 2), the shipper placed 16 pounds of ice in the center of a carton adjacent to the stems. The roses were packed with the blooms toward each end of the carton. The temperature of the flowers was about 35° F. at time of packing. They were held overnight at the packing plant in order to make an early-morning plane and left the San Francisco airport about 16 hours from time of packing.

The temperature of the stems in the center of the carton remained near the ice temperature, 32° to 35° F., for the entire transit period. However, temperatures at the ends of the carton adjacent to the blooms rose slightly at the airport in San Francisco (42°) and when the shipment was taken off the plane at Tampa, Florida, to await a connecting flight to Orlando, the temperature rose from 40° to 61°. There was a slight rise to 62° during the short flight from Tampa to Orlando. The difference in temperature between the ends and center of the carton was about 28 degrees when the shipment arrived. The blooms, which are the most fragile part of the flower, were therefore exposed to the highest temperature.

Forty-two hours elapsed between packing and delivery.

A considerable portion of the ice remained when the shipment arrived, which was further evidence that the ice was doing a poor job of refrigeration--only the stems adjacent to the ice were cooled.

The roses were in fair condition on arrival, but one bunch was off color and unsalable. The rest were still salable when held 1 day at 70° F. after 4 days at 40°.

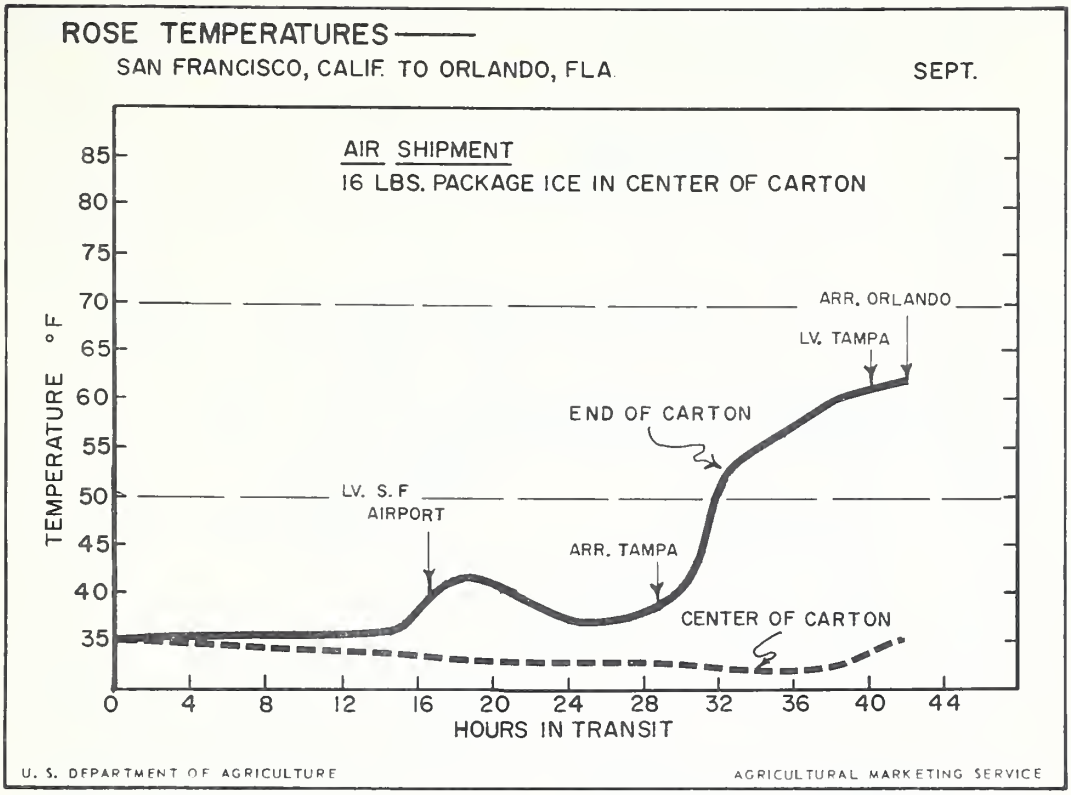

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Figure 2. --Transit times and temperatures of roses shipped by air from San Francisco Bay area (Mt. Eden) to Orlando, Fla., Sept. 26, 1960.

Carnation Shipment to New York, N. Y.

Freezing is sometimes a problem in flowers shipped during cold weather. Temperatures were studied in carnations shipped from San Francisco to New York in February (fig. 3). In this particular shipment, the flowers remained on the same plane for the entire flight, and were in the 50° to 60° F. range for most of the transit period. The temperature in the center of the carton remained fairly constant, but temperatures at the ends of the carton fluctuated considerably. There were noticeable drops in temperature when the plane was on the ground in Chicago and Detroit. The time from packing to delivery in this particular test was about 20 hours.

Stock and Daisy Shipment to Washington, D. C.

In May a carton of stocks and a carton of daisies were shipped from Los Angeles to Washington, D. C. Average temperatures in the centers and near the ends of the two cartons are shown in Figure 4. The flowers were packed at 9:00 a.m. and had an initial temperature of about 60° F. The shipment left Los Angeles at 11:30 p.m., arrived in Washington the next morning at 7:15 a.m., and wasn't delivered to the florists until 3:00 p.m. The time from packing to delivery totaled about 28 hours, of which less than 5 hours were spent in the air.

Temperatures in the centers of the cartons gradually rose to 66° F., dropped slightly during the flight, and were about 65° at delivery. Greater temperature fluctuations occurred at the ends of the packages. Temperatures rose to about 67° while the flowers were in Los Angeles, dipped in the evening hours to about 58° and were close to this level during transit. After arrival in Washington, the temperatures at the ends of the boxes increased rapidly to 71°.

The stocks and daisies were in fairly good condition on arrival. After 1 day at 40° F., they appeared to be in much better condition, the flowers, stems, and leaves having become more turgid. They remained in very good condition during 4 days' holding at 40°.

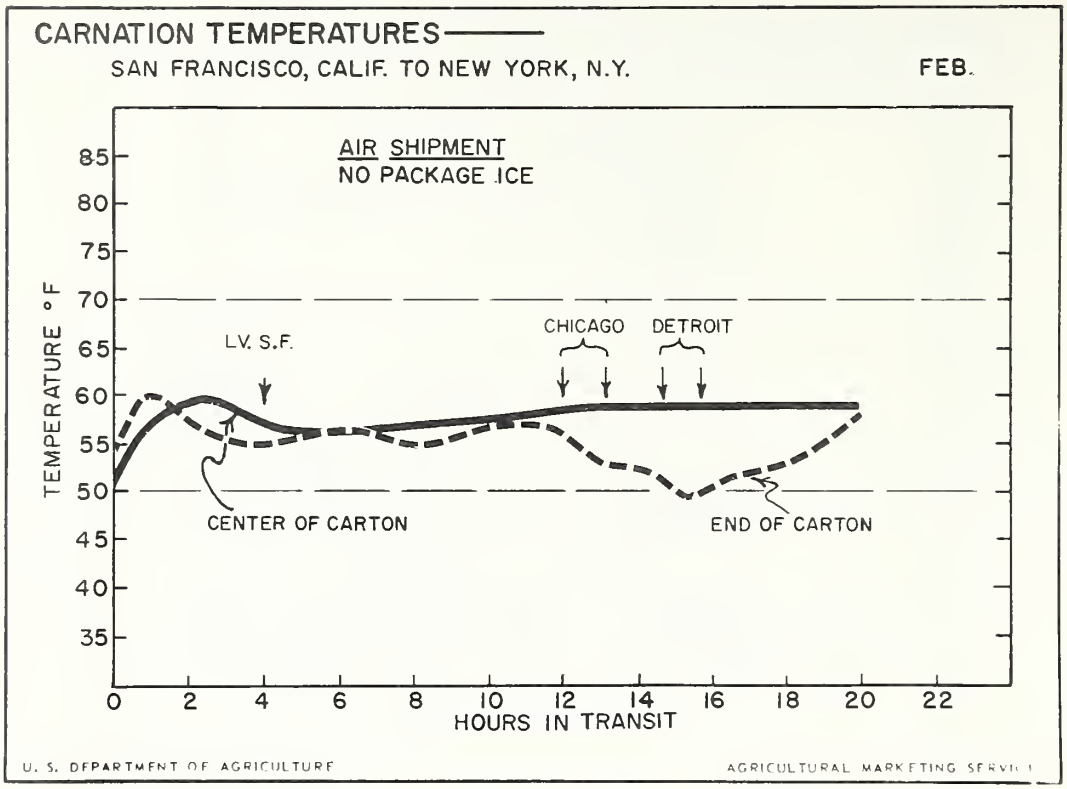

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Figure 3.--Transit times and temperatures of carnations shipped by air from San Francisco Bay area (Union City) to New York, N. Y., Feb. 8, 1961.

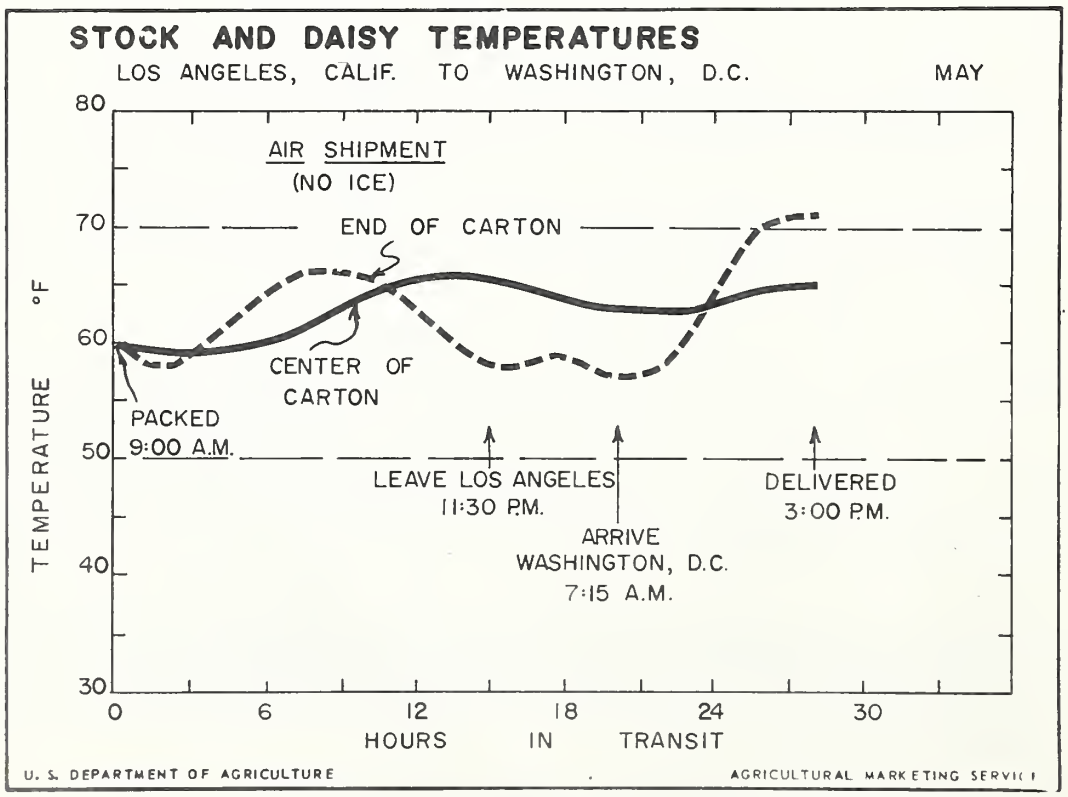

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Figure 4.--Transit times and temperatures of stocks and daisies shipped by air from Los Angeles, Calif., to Washington, D. C. May 15, 1961.

After 4 days at 40° F. plus 2 additional days at 70°, the stocks were classed as unsalable and were discarded. The daisies remained in salable condition a full 3 days at 70° after removal from 40°.

Stock and Aster Shipment to Orlando, Fla.

A carton of stocks and a carton of asters were shipped from Los Angeles to Orlando, Fla., in May (fig. 5). The flowers were packed about 9:00 a.m., May 15, and arrived in Orlando at 9:00 p.m. on May 16. They were delivered to the florists the following morning, about 48 hours from time of packing.

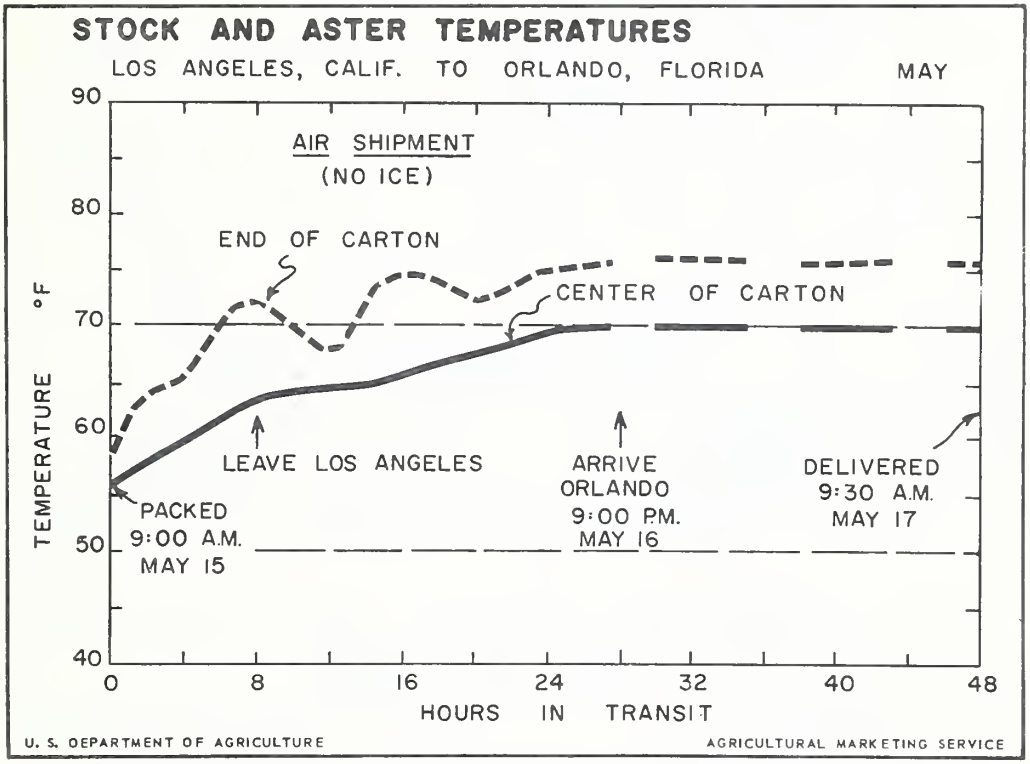

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Figure 5. --Transit times and temperatures of stocks and asters shipped by air from Los Angeles, Calif., to Orlando, Fla., May 15, 1961.

Average temperatures in the centers of the two cartons were about 57° F. at packing and rose gradually to about 70° at arrival in Orlando. The recorders used in these tests ran only for 30 hours, so the temperatures between arrival and delivery were not measured. Temperatures at the ends of the cartons increased rapidly at the Los Angeles airport, dipped while in flight, increased at transfer points, and were about 76° at arrival.

Both the stocks and asters were considered in good condition on arrival. They were kept at 45° F. for 4 days and then placed at 70°. After 2 days at 70°, both asters and stocks were not marketable.

Stocks Shipped by Truck to Harlingen, Texas

Cartons of mixed flowers were shipped from Los Angeles to Harlingen, Tex. Two bunches of stocks in each carton were used for the holding tests at destination. The flowers were packed on the morning of May 15, remained in the wholesale market area until 3 to 4 p.m., and were hauled to Bakersfield by truck. At Bakersfield, they were transferred to a refrigerated truck, which carried them to San Antonio. Here they were transferred to an unrefrigerated truck which arrived in Harlingen on the night of May 17. The flowers were delivered on the morning of May 18, about 72 hours from time of packing.

One carton had about 8 pounds of ice placed in the center and the other had a like amount of ice placed at one end. In both cartons the ice was wrapped in newspaper.

The package with the ice at the center (fig. 6) gradually cooled in the center position from an initial 70° F. to slightly below 50° while in the refrigerated truck. The temperature at this position rose to above 75° following the transfer at San Antonio. Temperatures at the end of the carton increased until transfer to the refrigerated truck, after which they dropped rather rapidly and fluctuated womewhat enroute to San Antonio. There was a rapid rise to above 80°, following the San Antonio transfer.

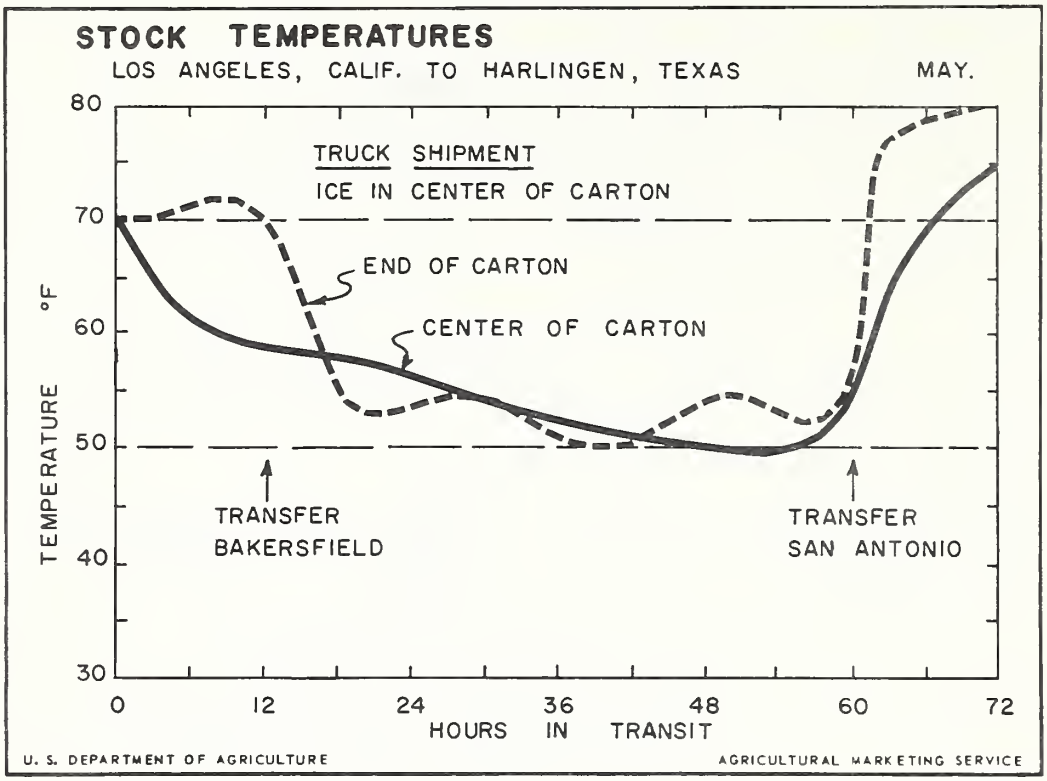

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Figure 6. --Transit times and temperatures of stocks shipped by truck from Los Angeles, Calif. to Harlingen, Tex., May 15, 1961.

The package with the ice at one end (fig. 7) had center temperatures that were generally higher than in the other carton. Temperatures at this position were above 60° F. for a considerable portion of the time. The end next to the ice cooled quite rapidly to about 55° and later to 50° when in the refrigerated truck. The temperature at this position reached a low of 47°, but increased to 72° following the San Antonio transfer. Temperatures at the end opposite the ice responded quickest to ambient temperatures, increasing both at the beginning and end of the transit period and responding quickest to the refrigeration enroute.

The stocks seemed to carry a little better in the carton with the ice at the center than in the one with the ice at one end. However, all were still salable after 4 days at 40° F. plus 2 additional days at 70°.

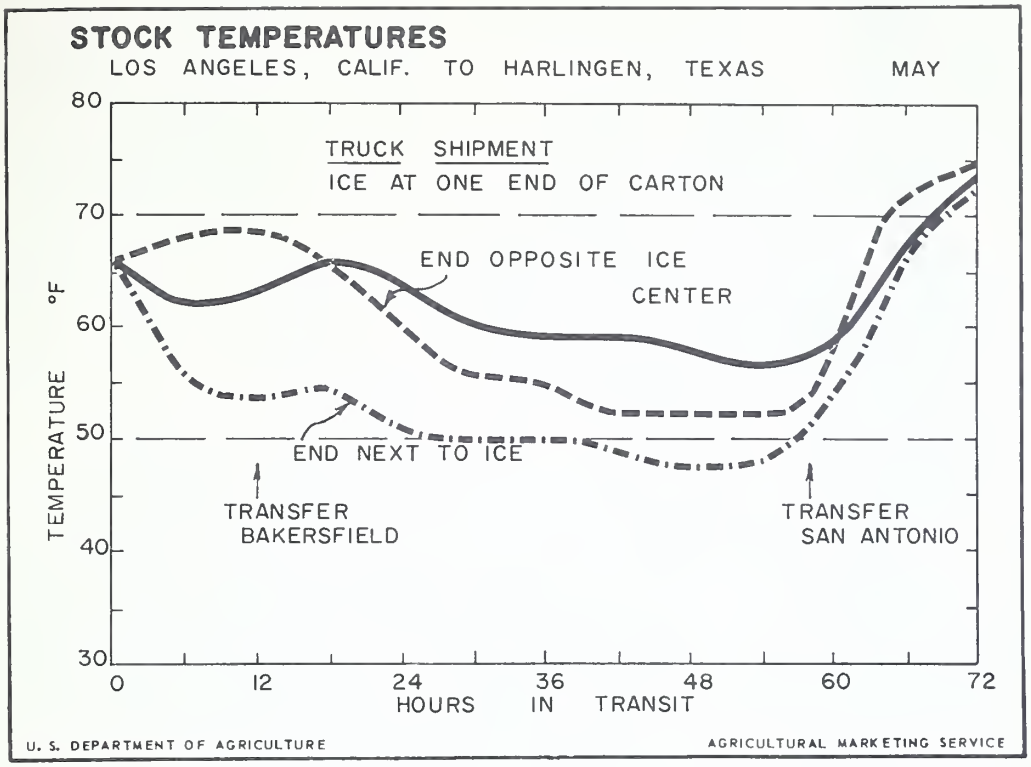

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Figure 7. --Transit times and temperatures of stocks shipped by truck from Los Angeles, Calif. to Harlingen, Tex., May 15, 1961.

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